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The Expansion of Educational Science Articles in Scientific American

Jonathan M. Rheaume
Worcester Polytechnic Institute

Luke A. Jackson
Worcester Polytechnic Institute

Matthew W. Nicholson
Worcester Polytechnic Institute

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The Expansion of Educational Science Articles in *Scientific American*

Interactive Qualifying Project Report completed in partial fulfillment
of the Bachelor of Science degree at
Worcester Polytechnic Institute, Worcester, MA

Submitted to:

Professor Steven C. Bullock

Professor M. David Samson

Luke Jackson _____

Matthew Nicholson _____

Jonathan Rheume _____

ABSTRACT

This project considers *Scientific American* in the late 1860s. The project team indexed volumes 14 to 21 of the New Series to be added to the online database of images and fixed significant problems that had hindered access to the database over a number of years. The team also examined changes in the magazine itself in these years, specifically the rise of general scientific discussions in a magazine previously devoted to inventions.

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AUTHORSHIP

Abstract	Project Team
Table of Figures	Jonathan Rheume
Table of Tables	Jonathan Rheume
Authorship	Jonathan Rheume
Introduction	Luke Jackson
Cataloguing <i>Scientific American</i>	Matthew Nicholson
Technical Difficulties and Resolutions	Jonathan Rheume
Growth of Popular Interest in Science	
Post-Civil War Trends, American Reconstruction Period	Luke Jackson
Magazine Circulation Boom	Matthew Nicholson
Growth of Educational Institutions	Matthew Nicholson
Growth of Educational/Science Magazines	Jonathan Rheume
Physical Changes in <i>Scientific American</i>	Matthew Nicholson
Increase in Pedagogical Entries	Jonathan Rheume
Recommendations for Future Teams	Jonathan Rheume
Conclusion	Jonathan Rheume

INTRODUCTION

This project continued an effort to catalog and investigate engravings published in the early years of *Scientific American*. It is the seventh project in a series of Interactive Qualifying Projects (IQPs) sponsored by the American Antiquarian Society that seeks to create a specific tool to assist historians of imagery. The goal of this project is to create an easy-to-use online database containing images from *Scientific American*. Cornell University's *Making of America* website was used, as it contains full issues of *Scientific American* from 1845 until 1869.¹ The present team's IQP focused on the years from 1866 to 1869. All of the magazine issues contained on this individual website are now documented in the database.

The *Scientific American* in the late 1860s gave much more attention to education in the broader applications of science, while continuing the coverage of technology and applied science for which the journal was known. The research portion of the project looked at the changes made by Munn & Co., the patent law firm which published *Scientific American*, upon the magazine during the late 1860s. These partially involved a change of format. The magazine itself was enlarged in 1867, and patent listings, which formerly included short and often confusing descriptions of the invention, began to note only patent number, title, and patentee with issues starting in 1869. As patents were originally the core of Munn & Co.'s business, the modification indicates a change of direction for the magazine. Both changes allowed an increase of content in each issue. Less visible changes were also important. The magazine began to include weekly article series that could span months of issues and through a more active and intense

¹ "Browse Making of America." Making of America. Accessed September 21, 2015. <http://ebooks.library.cornell.edu/s/scia/>.

“Correspondence” section, Munn & Co. assumed a more educational stance, informing their readers on current scientific topics.

The project also resolved some issues with the database itself, transferring ownership of the database to Professor Steven Bullock and updating the text of the website. While minor, these changes keep the database up to date and constantly accessible.

CATALOGUING IN *SCIENTIFIC AMERICAN*

Scientific American is a popular science magazine that began in 1845 and is still published today in 2016. It is the oldest continually published monthly magazine in the United States. In 2007, the American Antiquarian Society, which holds the nineteenth-century issues of the periodical, proposed electronically cataloguing its images as a means of making these illustrations more available to scholars. The project teams have used scans of *Scientific American* available at Cornell University Library’s *Making of America* site. This website is used because it offers easy access from any location for students. Cornell University Library’s website carries all of the issues of the *Scientific American* from Old Series Volume 2 in 1846 to New Series Volume 21 in 1869.² Over the past seven years, Interactive Qualifying Project groups from Worcester Polytechnic Institute have prepared an online database and website where every illustration within these issues from 1846-1869 is indexed. The 2015-2016 team completed the cataloguing of the database for the volumes contained on Cornell’s website by collectively finishing all of the issues from years 1866-1869. This constitutes two hundred and eight issues containing 2329 individual image entries.

² Making of America.

Cataloguing the entries requires the organizing of each engraving into nineteen different categories. The categories are as follows: Title, Image Description, Artist, Article Summary, Inventor, Author, Patent Date, Subject(s) 1-3, Keywords, Date, Publication, Volume, Issue, Page, Series, People Involved, and URL. A brief description of each category is given in Table 1. Also listed in Table 2 are the twenty-four subjects that any given image and article can be categorized in. These standards were set by previous project teams and finalized in 2011. They have since remained consistent and remove the uncertainties of interpretation between individuals.

Table 1: Column Names and Their Definitions

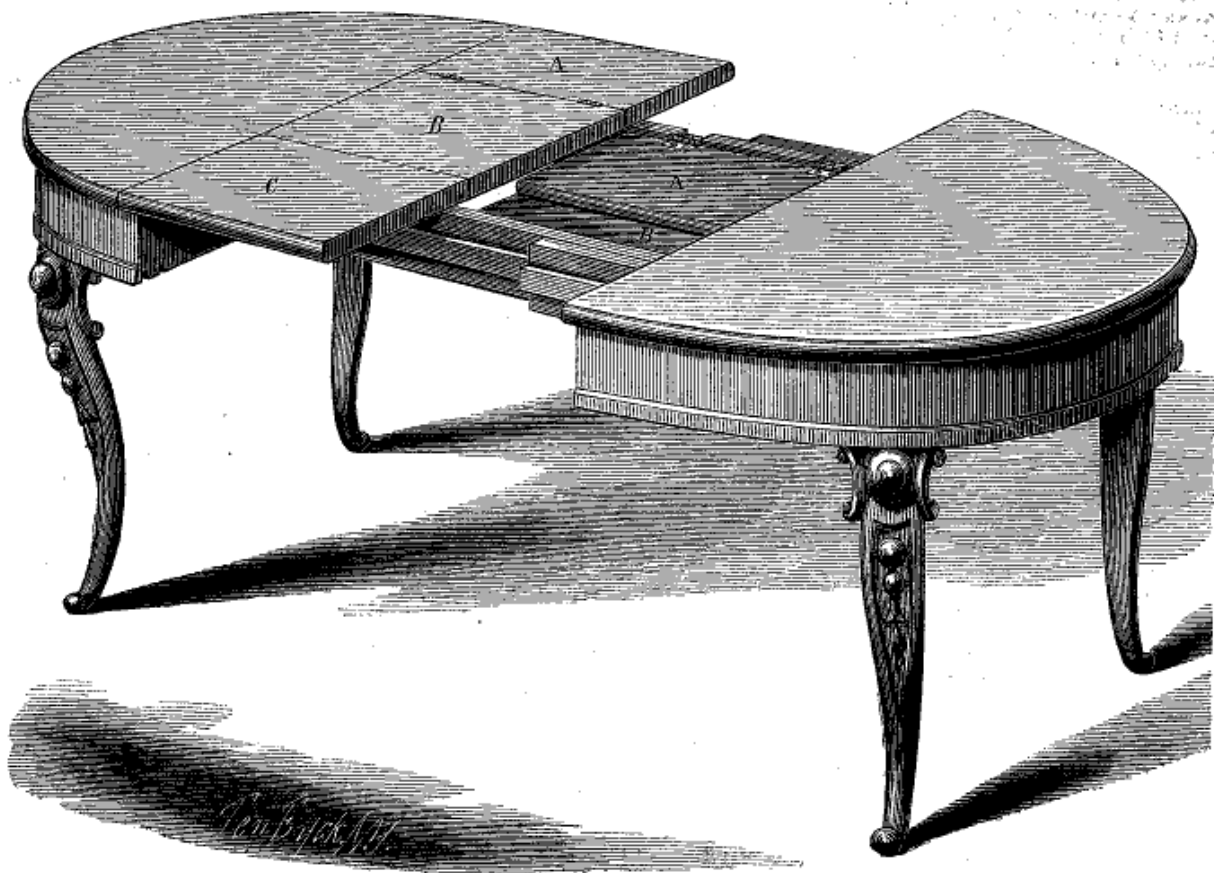
<u>Column Name</u>	<u>Definition</u>
Title	The title of the image as it appears on <i>Scientific American</i>
Image Description	Description of the viewpoint of the image
Artist	The engraver who worked on the image. Omitted if missing or illegible
Article Summary	Summary of the article accompanying the image. This is relatively brief, describing how the device operates, what improvements have been made, or the purpose of the image
Inventor	The individual(s) who invented the object
Author	Author of the article, omitted if missing
Patented	The date that a patent was issued for the invention
Subject	Selected from the list of subjects given in Table 2
Subject 2	Same guidelines for Subject, if applicable to multiple categories
Subject 3	Same guidelines for Subject, if applicable to multiple categories
Keywords	Relevant words or phrases, determined by the cataloguer at the time of submission
Publication	Publication the image is found in
Date	Date on which the issue containing the issue was published
Volume	Volume in which the image was published
Page	Page on which the image appeared in the respective issue
Series	Listed as the article title, “x of y”, showing how many images are contained in the article

People Involved	Anyone who was not included in the earlier fields, often manufacturers, merchants, or other related agents
URL	A link to the scan of the page containing the image on Cornell University Library's "Making of America" website, if available
Dateint	An 11 digit integer, essentially the same entry as the Date field, used by the database to sort entries by date

Table 2: Subject List

Aerial Navigation	Agricultural Implements and Operations
Arts – Fine, Polite, and Ornamental	Calorifics, Lamps, Stoves, etc.
Chemical Process, Manufacture and Composition	Civil Engineering and Architecture
Education and Instructional	Electrical Powered Devices
Fire Arms and Implements of War	Grinding Mills and Mill Gearing
Household Furniture	Hydraulics and Pneumatics
Land Conveyance	Leather – Tanning, Dressing and Manufacturing
Lever, Screw and Other Mechanical Power	Lumber, Machines for Manufacturing
Manufacture of Fibrous and Textile Substances	Mathematical, Philosophical, and Optical Instruments
Metallurgy and Manufacture of Metals	Miscellaneous
Navigation and Maritime Implements	Steam and Gas Engines
Surgical and Medical Instruments	Wearing Apparel and Implements for Manufacturing

For example, following is an actual image taken from *Scientific American* as well as the indexing that was put into the database to better illustrate the inputting process.



J. B. CURTIS' INCLOSED LEAVES EXTENSION TABLE.

Figure 1: Example Image from *Scientific American*

Based on the methods used during this project, this image from an 1868 *Scientific American* issue would be indexed in the following way.

Table 3: Example Indexing from Database

Field	Value
Title	J.B. Curtis' Enclosed Leaves Extension Table
Image Description	Isometric View
Artist	Ten Eyck
Article Summary	An extension table that allows the owner to put the extra leaves inside the table itself for storage
Inventor	J.B. Curtis
Author	None
Patented	1866-11-06
Subject 1	Household Furniture
Subject 2	None
Subject 3	None
Keywords	Extension, Table, Household, Furniture, Leaves, Enclosed
Publication	Scientific American New Series
Date	1868-03-14
Volume	18
Issue	11
Page	168
Series	None
People Involved	None
URL	http://ebooks.library.cornell.edu/cgi/t/text/pageviewer-idx?c=scia;cc=scia;idno=scia1018-11;node=scia1018-11%3A1;view=image;seq=172;size=175;page=root

Two methods were used to collect information from *Scientific American* when cataloguing images. At first, all team members began the collection of information by typing it into an Excel spreadsheet. Each row corresponded to an index category and the image information was stored without actual entry into the database. The fields could then be copied and pasted into the database input module at a later point. This was necessary because of technical issues that prevented the input module from functioning properly. Once all of the technical difficulties were resolved it was possible to simply enter the information directly into its field and submit the index to the database. An advantage of this direct method of cataloguing was that it decreased the number of steps required to store information in the database.

Using the Excel spreadsheet also had advantages. It made it possible to copy and paste whole entries for multiple images of a single series. Another advantage of storing the information in a spreadsheet first is that it could be easily re-entered again, if necessary. The database input module offers one chance to double check the work but then cannot be edited after a second acceptance. The only manner in which an entry can be changed after being accepted into the database is to delete the old entry and start anew. Therefore, having a copy of the fields saved prevents the need to reread any of the article. Regardless, through our observations we determined that the time required for entering a full volume by either method was relatively equal, and it became a personal choice of each team member for how he preferred to index the information.

TECHNICAL DIFFICULTIES AND RESOLUTIONS

In the process of updating the *Searchable Database of Early American Mechanical Drawings* during the first term of this project, a number of technical issues had to be addressed. Obstacles were met in obtaining permission settings, code indices, and database ownership.

Outlined here are the issues, steps taken to resolve them, and expected outcome for any teams that may work on this project at a future date.

The first step taken was to gain access to the *sciam* user file, which required Professor Bullock to enter the student's username into the permissions listings. After that, all files pertaining to the .html and java scripts for the website were available by mapping the network drive of *sciam* when on WPI's internet service, or by using the program WinSCP when off campus. This part of the process posed no difficulties.

At this point, however, the website www.users.wpi.edu/~sciam/sciam.cgi would not compile properly, and the database as a whole was inaccessible. Our team contacted Tori Miller and Tyler Alexander from the 2014 team, and they shared some of their old Helpdesk receipts to provide a direction from which to approach the problem. They noted that in the past, there had been a problem with the *edituser* and *sciamimgdisplay* commands. By directing the Helpdesk with these hints and referencing the old ticket numbers, we successfully launched the main database site and search engine (Case 169757, logged on 9/18/2015, resolved on 9/24/2015).

The next difficulty was gaining entry to the input module, which requires a username and password on the *Searchable Database of Early American Mechanical Drawings* website itself. Again, internal errors and missing pieces in the java script were to blame for the issue. The Helpdesk directed the troubleshooting towards the "automatic website permissions tool," but this failed as the current team is not the owner of the database within WPI's UNIX system. Additional problems were a result of a missing index file to store page information. These problems were resolved shortly before the A/B term break (Case 170665, logged on 9/27/2015, resolved on 10/14/2015). Upon return to campus it was found that the website and user login failed to load properly and once again assistance was required to determine why the user files

had disappeared. Another case was opened with the Helpdesk (Case 173803, logged on 10/28/2015, resolved on 11/10/2015). Mark Taylor, who helped on this ticket, did the most to explain where the issues with the database might have originated.

The technical issues faced by this group and previous teams resulted from a single cause. The ownership of the MySQL database on WPI's servers and some of the code saved in the *sciam* user account belonged to a student who has since graduated from WPI. This is no surprise as this Interactive Qualifying Project was launched initially in 2008. However, as a part of the automatic server maintenance done at WPI, all account information pertaining to this graduate is deleted at the beginning of each term. This is why some of the data needed to launch and edit the website are consistently lost. To remedy this issue, the ownership of the MySQL database was transferred to Professor Bullock's user account, which should allow the database to stay active until he leaves the Institute. The first test of this was at the beginning of C-term, 2016, in which the solution succeeded and the database remained easily accessible. There have been many roadblocks that cost significant time at the outset of this project in 2015-16, but having been given the proper care and attention, they appear to be resolved permanently and will support the longevity of the database. Once all the technical issues in cataloguing were taken care of, the focus was shifted from indexing to learning about *Scientific American* during this time period.

GROWTH OF POPULAR INTEREST IN SCIENCE

While cataloguing *Scientific American*, it was observed that a number of educational articles that did not seem to fit the description of what our initial understanding of the magazine was. Changes could be seen within the relatively short period of time between 1866 and 1869 where the magazine modified not only its format, but more interestingly, its content. *Scientific American* was developing a greater authority on applied sciences. While the institution was

known for its understanding of inventions, *Scientific American* was now sharing a knowledge of scientific principles and their effects on inventions and in the subscriber's daily work.

Despite the Civil War, *Scientific American* continued to publish and to dedicate its columns to inventions and their descriptions. This focus continued after the war, but later parts of the decade also brought new sorts of content. The editors of *Scientific American* published explanations, proofs, and lectures from a variety of contributors including professors from newly instituted universities, local inventors and patent owners, and excerpts from established science journals in England and France. Topics broadened to include astronomy, natural history, agriculture, steam engines, transportation, communication, and short biographies of famous scientists and inventors. *Scientific American* was developing from a magazine that covered patents into a much more broad and encompassing work that expounded teachings in science and engineering alike.

POST-CIVIL WAR TRENDS, AMERICAN RECONSTRUCTION PERIOD

From its inception, *Scientific American* had covered inventions. This began to change in the late 1860's. Although patents remained the primary focus of the magazine, other materials began to be included. *Scientific American* faced a slew of editorial changes in the mid 1860's, as John W. Combs, Robert MacFarlane, and Salem Howe Wales all left the firm. John W. Combs was an assistant editor from the years 1852 to 1864, and Robert MacFarlane edited from 1847 to 1864. Salem Howe Wales stopped editing in 1868, and officially left the firm of Munn & Company in 1871.³ It is not clear who filled the journal's editorial posts from this point, but it is clear that the tone of the magazine was changing. Correspondence was highlighted, and a

³ Borut, 236.

striking number of articles taken from outside journals was included. Some popular journals that the magazine drew from included the *London Engineer*, *Engineering*, *American Entomologist*, *Workshop*, and *Sloan's Architectural Review and Builder's Journal*. By 1869, the material from outside journals, which had been rare before this period, had become a staple, often supplying two or three articles per issue of *Scientific American*.

Instructive and educational writings, both formally in the format of lectures, and informally in the form of correspondence, were included more often. Some of the authors were faculty members at post-secondary institutions, other authors were respected scientists or practical engineers. One example of a formal lecture was included in the June 6, 1868 issue, entitled "On Musical and Sensitive Flames."⁴ The lecture was provided by W. F. Barrett to the Dublin Royal Society. The correspondence section provided the greatest evidence of reader contributions to the instructive content of the magazine. While the section was initially used by the editors of *Scientific American* to respond to individual letters addressed to the magazine, it developed into an effective forum where science was discussed. The editors would often comment with their best opinions or reasoning on the importance of a topic, such as a comment contained in the correspondence section of the November 24, 1866 issue. The comment reads,

"The importance of a correct knowledge of the relative positions of the piston and crank of an engine will be conceded by those who have to set the valves on steam engines. We think our correspondent has thrown some light on the subject by his diagram. An old and experienced engineer told us, the other day, in speaking on this subject, that of several hundred engines he had indicated, the valves, in nine-tenths of them, were wrongly set to get the maximum amount of power for the steam used. In some cases the loss was nearly thirty-three per cent. It is, therefore, important to know the exact relative positions of piston and crank in different points of the stroke. -EDS."⁵

⁴ *Scientific American*. June 6, 1868, 355.

⁵ *Scientific American*. November 24, 1866, 353.

Patents were still highlighted, and remained the main focus of the magazine, but correspondence between editors, professors, and engineers began to occupy a greater proportion of the weekly publication.

Another example of the use of the correspondence section can be seen in 1866 between three authors discussing the position of a piston when its crank was vertical, relating to an engine's stroke. This is the same conversation that prompted the editors' response, given above. The articles from this conversation were all included in volume 15, and were from different issues throughout the year.⁶ The articles were usually a single column in length, accompanied by diagrams, and the authors discussed how to determine the position of a piston in relation to the phase of the engine's stroke. While this series of responses is quite lengthy, it can be taken as indicative of the efforts of Munn & Co. to provide expert opinions on topics important to the subscribers. An example of a recurring article was the "Beet Root Sugar" series, which ran weekly from March 27, 1869 to June 5, 1869. Eleven articles were issued, detailing the process, machinery, labor, and costs of operating a factory dedicated to the production of sugar. *Scientific American* stated, at the end of the final article,

"We shall regret neither the space [these articles] have occupied in our paper nor the labor we have bestowed upon them, if they prove to be the means of stimulating the establishment on a firm basis in the United States of a most important branch of agricultural industry."⁷

Scientific American no longer had eyes for just inventions. They began to look at the economic effects of improving technology in a capitalist environment, the competition between America and foreign powers, and the nationalistic view of American manufacturing. *Scientific*

⁶ Searchable Database of Early American Mechanical Drawings.

⁷ *Scientific American*. June 5, 1869, 354.

American wanted not only to explain how science and technology could be understood, but also how they had real merits in daily life and economics.

MAGAZINE CIRCULATION BOOM

From its onset and into the first several decades of existence, the sales of *Scientific American* magazines increased gradually. The magazine was originally created by Rufus Porter in 1845, but he soon sold its rights to Orson Desaix Munn, who would eventually create Munn and Co. Under Munn's control, the magazine's overall sales grew to an impressive number. The number of subscribers climbed up to 30,000 by 1859, but by the middle of the Civil War in 1863, annual subscriptions had fallen to roughly 15,000. However, in the years following the Civil War *Scientific American* completely rebounded and by 1872 about 50,000 issues were sold each week.⁸ More and more people across America were gaining interest in science, engineering, and inventions, and *Scientific American* provided an outlet.⁹

Before the 1860s and 1870s, Munn and Co. had the luxury of being one of the only serious patent agencies in America. In 1860, they facilitated approximately one third of all patent applications in America, and in 1865 alone they filed 3,500 applications for their clients.¹⁰ Since Munn and Co. had achieved such great success from patents, their *Scientific American* logically became the premier magazine for reading up on the latest inventions and patents. As a young boy, Thomas Edison walked three miles every week to get a copy of the magazine.¹¹

The American market for magazines increased significantly after the Civil War and *Scientific American* had to adapt its practices to continue as a unique and successful business.

⁸ Borut, 208.

⁹ Mott, 346.

¹⁰ Hutchinson, 1.

¹¹ Mott 347.

Specifically during the late 1860s, *Scientific American* encountered changes that would affect the overall sale of issues. By the end of the Civil War there was a shortage of newsprint, so Munn and Co. decided to raise its subscription fee from two dollars per year to three dollars per year. Nonetheless, in 1866 the pages of the issues were enlarged to be fifteen by ten inches instead of the standard eleven by eight and a half so that more information could be distributed to readers.¹² Despite the fact that the annual fee had to be raised, the increase in size of each issue could have contributed to a rise in subscribers.

Scientific American aside, magazines in America overall were booming during this time period for a number of reasons. This can be credited to the rise in literacy, more efficient printing presses, and better forms of transportation. More and more interested Americans picked up subscriptions to *Scientific American* to learn new information about scientific inventions and theory.

GROWTH OF EDUCATIONAL INSTITUTIONS

During the late 1860s, *Scientific American* began to publish more and more excerpts from faculty members' lectures at universities. This was one of the several changes that the firm was making at this time in order to reach a larger audience and solidify its place as the premier popular science magazine. The 1860s was a time of great scientific expansion not just in America, but also around the globe. As a result, more and more college-level educational institutions came into existence, including colleges that strictly focused on science and engineering. In the northeast alone, Massachusetts Institute of Technology, Worcester

¹² Borut, 212.

Polytechnic Institute, and Stevens Institute of Technology were founded in 1861, 1865, and 1870, respectively.

One of the most prominent changes in the magazine noticed from this time period was the increase in pedagogical articles when compared to earlier years of *Scientific American* (see Observations While Cataloguing). One such example was in an issue from July of 1868 that dealt with the general concept of gunpowder and how it is manufactured. The creation of centers of engineering-based learning geographically close to Munn & Co. offer a possible explanation for the increase in pedagogical engraving and articles. These new institutes and their knowledgeable faculty brought a new way for Munn and Co. to try and sell more copies of their magazine and differentiate themselves from competition. The idea was to take summaries of lectures from these professors and put them into their weekly issues. As a result, from 1866-1869 there were numerous instances of lecture summaries in *Scientific American*. These summaries came from a wide range of scholars, from relatively unknown academics to renowned physicist and chemist Michael Faraday. Sometimes, the lecture summaries would be so long and in depth that they would have to be put in consecutive weeks to finish up the summary. An example of this was a lecture from John Tyndall, a professor of physics at the Royal Institution of Great Britain, that *Scientific American* called "Heat and Cold." This lecture spanned six different issues in 1868, from February 8th to April 4th.

One explanation for the increase of pedagogical articles during this specific time period could be due to a shift in educational philosophy. At this time in American history, most institutions of higher learning had multiple departments focused on varying topics. Schools had varying departments pertaining to law, English, etc. This was essentially the common way for American universities to operate. Engineering was not a common major in most ordinary

American colleges. It was primarily taught at military schools like West Point, Annapolis, and Norwich University. However, starting in about the 1850s, some educators started to believe in the French idea of having one institute that would offer many different types of engineering disciplines. This way, technical-minded students could be fully engaged in engineering classes, and be in an environment where everyone around them were aspiring engineers as well. These would be called “polytechnic” schools.¹³

The managers and writers at *Scientific American* understood that this change was taking place, and that this change in scientific education could potentially help their business. With these new polytechnic institutes came technically sound professors that gave valuable information to their engineering students. Consequently, *Scientific American* could now expand its content to include another aspect of engineering. *Scientific American* already had a large number of inventions in every issue, and with the addition of academic lectures it was able to become more multi-dimensional and could offer its readers more than competing scientific magazines.

GROWTH OF EDUCATIONAL/SCIENCE MAGAZINES

In 1865, the only significant science journals in the United States were the *Journal of the Franklin Institute* and the *Scientific American*. They were joined by the *American Naturalist* in 1867, but each still covered their own areas of the fields of science.¹⁴ “No one who watches the growth and progress of journalism,” observed the *Scientific American* in 1870, “can fail to mark the tendency of the age toward the establishment and support of publications devoted to

¹³ Clark, 279.

¹⁴ Mott, 345.

specialties.”¹⁵ There became a magazine for every specialty, each catering to a specific organization or trade. In particular, Americans were interested in technological advances and inventions that came as a product of the robust Industrial Revolution. An observer noted, “The leading feature of American science is its utilitarianism.”¹⁶ The *Scientific American* filled this niche through its precise images of the most influential inventions as well as the weekly list of all newly issued and reissued patents. Not only did they present these products, but they offered direction on how the reader could go about obtaining his own patents, encouraging further growth of their firm as well as American ingenuity. The postbellum period was filled with the activity of inventors and in turn exploded with a great increase of periodicals and publications focusing on patents and the scientific aspects of mechanics. New York, home of the *Scientific American*, saw rise to the *American Artisan and Patent Record*, the *American Machinist*, *Steam*, and the *Mechanical Engineer* in the decade following 1867.¹⁷

Scientific American began to discuss popular topics of interest in pure science most conspicuously at the beginning of the postbellum period. It served primarily as an applied science and technology journal in concord with the patent office but frequently concerned itself with pure science from the letters and lectures of contributors as well. With this increase in available space, they could expand on these new topics to stay ahead of other magazines. The patents were still a great focus within the magazine, but space was being dedicated for an increase of pedagogical lectures, correspondence, commentary, and discussion.

¹⁵ *Scientific American*. January 15, 1870, 47.

¹⁶ Mott, 348.

¹⁷ *Ibid*, 349.

PHYSICAL CHANGES IN *SCIENTIFIC AMERICAN*

The physical layout of *Scientific American* had experienced many changes by 1869 compared to the early years of its publishing. A decade earlier each weekly issue only had eight pages of information. This doubled with the introduction of the New Series in 1859, which introduced an oversized version of the paper. The columns were adjusted to be three inches wider, adding an equivalent of seven pages of content per issue.¹⁸ The periodical introduced this change to their readers on July 2nd, 1859 and explained that it, “will enable us to enter more extensively into the more important details of American and Foreign industry, Art, Science and discovery.”¹⁹ *Scientific American* wanted to expand on the information that they were presenting in each issue. The next major change occurred in 1866 at the end of the 14th Volume of the New Series. At this time, *Scientific American* began to include advertisements in its issues. The last two or three pages of each issue were allocated to businesses selling products for mechanics, carpenters, farmers, and other handymen. Additionally, the introduction of the New Series saw the patent claims move from being listed somewhat randomly in the middle of the 1859 issues to their end, directly before the advertisements. Similarly, *Scientific American* printed the patent claims with their detailed descriptions along with the patent number, assignee, and title but, in January 1869, stopped printing the patent claims, agreeing with complaints from readers that they “failed to provide intelligible knowledge of the thing patented.”²⁰ The revised patent listing averaged only a single page (as opposed to the previous three). With this space, the *Scientific American* was able to provide more detailed comments on the mechanical workings of

¹⁸ Borut, 210.

¹⁹ *Scientific American*. November 24, 1866, 357.

²⁰ Borut, 207.

inventions, applied sciences, and contributor lectures. These changes were recorded and noted by Munn and Co. with short summaries to the readers in the magazine itself.²¹

The project team has also identified more subtle changes in the content of *Scientific American* by direct observations during the cataloguing process. For example, in 1866, the sixteenth and final page was used as somewhat of a secondary front page. It always had at least one engraving, and included some of the newer and most interesting inventions of the issue. As previously noted, in 1869 there were no engravings at all on the last pages of the issues, instead being completely taken up by advertisements. Each of these alterations to the layout of *Scientific American* were executed by Munn and Co. to fit the desires of the readers and open their pages to newer content in the form of applied sciences.

INCREASE OF PEDAGOGICAL ENTRIES

Through the process of cataloguing the issues from 1866 to 1869, a trend of increasing “pure science” educational efforts was evident within the magazine. Their presence exceeded the small increase that began in 1859 with the issuance of the New Series and editor’s note that, “the increased space in our new series enables us to make a brief mention of new discoveries in every department of science.”²² It was observed that through the progression of time, there were more lecture contributions, explanations from editors, and academic sketches than there were at the start. To provide quantifiable data, the *Searchable Database of Early American Mechanical Drawings* was used first.²³ The “browse” feature of the engine allowed the term “pedagogical” to be searched under subject as well as the year to be specified. Upon this action, all images of this

²¹ Making of America.

²² Scientific American. December 10, 1859, 391.

²³ Searchable Database of Early American Mechanical Drawings.

nature are specified and the total number of them reported above the links to the actual content descriptions. To better understand the trend, data was collected from the years 1863 to 1869 and is shown in the graph below.

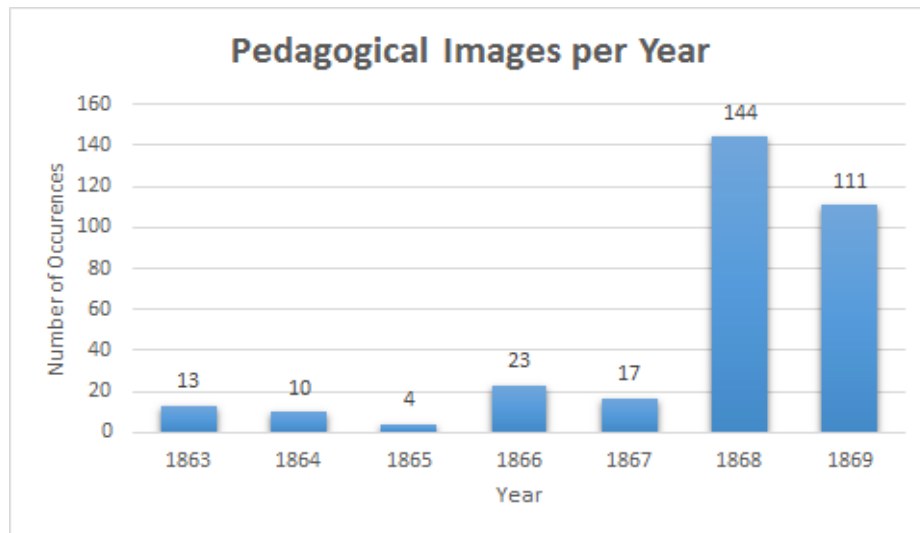


Figure 2: Summary of images categorized at “pedagogical” per year

The extremely sharp increase noted between the years 1867 and 1868 in Figure 2 seems surprisingly large; however, it is tempered by further research into the occurrences of pedagogical articles within the periodical that are not associated with an image. Including these articles allows for a more comprehensive study of the subject matter produced within *Scientific American* and evens out the trend lines to a more reasonable slope. To best represent each year, the number of articles were counted from three issues and summed. The earliest year recorded for this analysis is 1859, the first issue of the New Series, so that the number of pages is consistent in each issue. This study confirms that the number of academic and pedagogical pieces presented in the magazine were slowly increasing in the postbellum period. These charts show how the magazine had adapted over this time period, from being almost exclusively focused on patents to including educational and informative articles intended to enlighten readers and inspire creative thought.

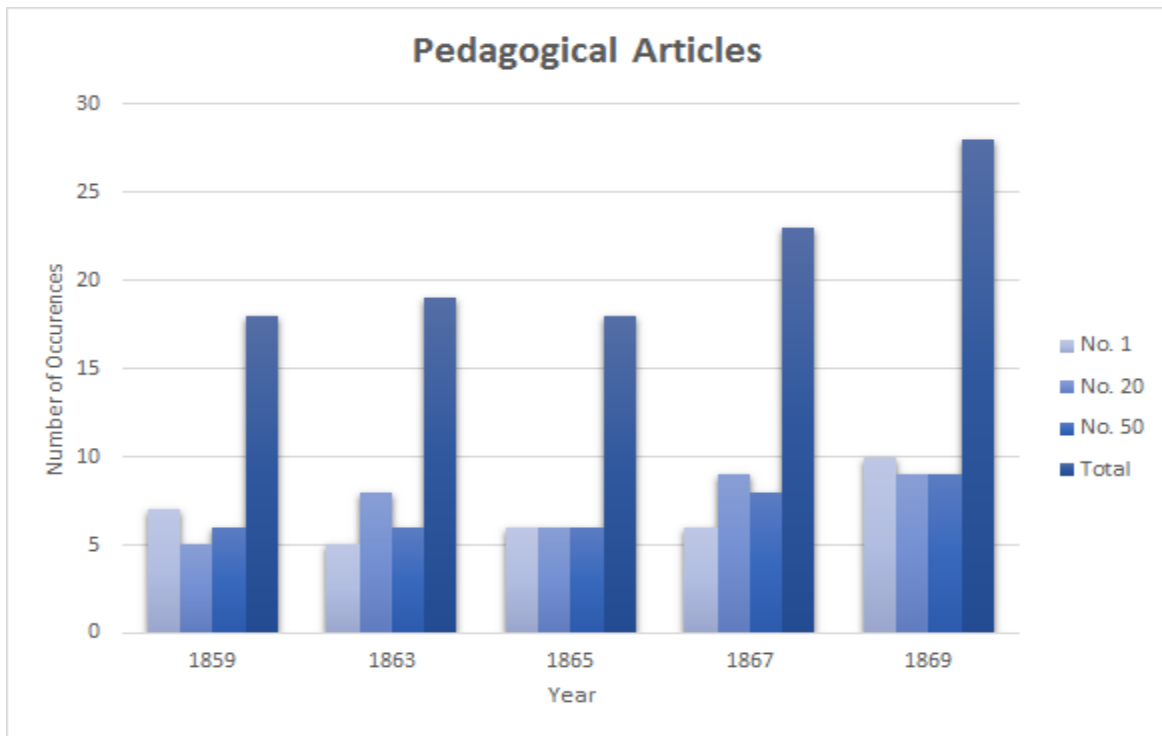


Figure 3: Summary of text only articles categorized as “pedagogical” per given issue

RECOMMENDATIONS FOR FUTURE TEAMS

Seven IQP teams worked on this database, but there is ample space for continuation. The primary goal of the next team should be on improvements of the database itself. These tasks would include updating the aesthetics of the site, fixing incongruences in categorization of images between years, and adding inputted entries to reflect the important factors of the newer content. Secondary to this technical aspect is further cataloging of issues after 1969.

Like the team from 2013-2014, this team lacked the computer science background necessary to make significant changes to the script of the database. Experience in SQL coding is especially important as it is the language of the data storage functions. It also serves as the direct interface for ensuring early entries to the database are updated to have content for any index categories that have since been added. This includes the option for “New Series” versus “Old

Series” in the publication section and future additions to reflect more general science topics included with the invention patents. The result pages of the basic and advanced searches of the database would also benefit from an overhaul. Currently results are organized by volume number, which has no real meaning for an individual searching the images. It would be better to sort results alphabetically by title, or chronologically by patent date.

The historical research presented in this report could best be confirmed by further cataloguing issues in the 1870s and beyond. As the longest continuously published monthly magazine in the United States, there is a vast amount of material to be indexed. If this were the case, then it would be important to reflect changes in content of articles with subject fields in the indices. Another option would be to keep the focus of the database on mechanical drawings and engravings and seek out other print sources for study.

No matter the choice of direction for this project, it is most important that the team continues to seek ways that they can involve applied research that connects science or technology with social issues and human needs as described by WPI. The addition of information to the database is useful for potential researchers but work by the team should incorporate their skills as engineers to best utilize and improve the access to the historical data being collected.

CONCLUSION

The goals of this IQP were to enter additional volumes of images and engravings from *Scientific American* to the online database and provide research into the beginning of content change within the periodical in the late nineteenth century. The largest amount of time on this project was spent manually cataloguing an additional four years' worth of issues into the database. The presence of the *Making of America* site helped make accessing the documents easier than flipping through the physical copies but scanning through over 1600 pages of work was tedious nevertheless. Other obstacles that became great time sinks were resolving several permission and ownership errors within the user files and WPI's UNIX database. These issues were resolved primarily with the assistance of the Helpdesk. Overall, 2329 images were catalogued during the first 14 weeks of the 2015-16 academic year.

The last seven weeks of the project focused on further developing research into observations that *Scientific American* had begun a transition to include more pure and applied science articles as opposed to its traditional exclusively mechanical patent content. Originally, we were informed that the magazine specialized in early American patents and inventions. This was reflected in the categorical fields for indexing the articles, which included inventor, patent date, and subject choices that fit this realm best. While cataloguing, the team noticed a trend of an increasing presence of "pedagogical" articles that discussed topics of science to offer the readers better understanding of how and why things may work a certain way. This was further explored by reflecting on the new presence of competition in the market for magazines, trends in education and the study of science as a whole in America, and specific studies of scientific journalism at the end of the nineteenth century. In viewing this wide background in which

Scientific American lived and analyzing specific quantifiable changes in the periodical we have determined that the years 1866-1869 do reflect the very beginning of a change in the publication's focus on science and invention in early America.

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